Original Article

Limited Vitrectomy in Patients with Idiopathic Macular Hole

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Background: Partial posterior hyaloidectomy is suggested to minimize the traction on the vitreous base and therefore reduce the risk of iatrogenic breaks in patients with macular hole and epiretinal membrane.
Aims: To evaluate the safety and effectivity of limited vitrectomy in patients with macular hole.
Study Design: Retrospective cohort study.
Methods: Fifty-two consecutive patients who underwent macular hole surgery without performing complete peripheral vitreous removal were included in the study. The improvement in visual acuity, the incidence of retinal breaks and detachment, anatomical results and intraoperative and postoperative complications of this technique were evaluated.
Results: The median visual acuity was 0.2 (0.1-0.4) before surgery, ant it was 0.5 (0.3-0.6) after surgery ($p<0.001$). Retinal breaks and detachments did not occur in any of our patients. SF_6 was used in 24 patients (46.2%), and C_3F_8 was used in 28 patients (53.8%) Three patients (5.76%) had revision surgery because of the recurrence of macular hole. We did not observe proliferative vitreoretinopathy or surgery related major complications in any patient during the follow up period.
Conclusion: Limited vitrectomy without removing peripheral vitreous is safe and effective in macular hole surgery. It reduces the risk of peripheral retinal breaks and retinal detachment.
Keywords: Limited vitrectomy, macular hole, pars plana vitrectomy, retinal breaks, retinal detachment

Idiopathic macular holes are full-thickness retinal defects in the neurosensory foveal retina. The classical approach in macular hole surgery is pars plana vitrectomy, internal limiting membrane (ILM) peeling, gas tamponade and face down positioning. Classic pars plana vitrectomy (PPV) requires complete removal of the vitreous including vitreous base. However, the aim of the macular hole surgery is to remove tangential and anteroposterior vitreous traction, induction of activity of marginal glial cells by vitrectomy and epiretinal membrane (ERM) peeling, and reconstruction of hole edges by intraocular gas tamponade (1). All of these procedures are performed in the macular area.
In macular surgeries such as macular hole and epiretinal membrane, we routinely do not perform a complete vitrectomy. We believe that this method might reduce complications such as iatrogenic retinal breaks, and it does not affect the anatomical and functional results. The aim of our study is to evaluate the safety of limited vitrectomy in patients with macular hole.

MATERIALS AND METHODS

Records of the patients who underwent vitrectomy for idiopathic macular hole were reviewed retrospectively. The follow-up visits were at 1st day, 1st week, 1st month, 3rd month, 6th month and 12th month. The 12th month examination results were evaluated in the study. Ethics Committee of the Kocaeli University approved the study.

Surgical Technique:
Vitrectomy was performed with standard 23 gauge instruments (OS4, Oertli Instrumente AG, Berneck, Switzerland), and a non-contact viewing system Oculus BIOM (Oculus Surgical, Port St. Lucie, FL, USA) was used in all patients. After core vitrectomy, posterior vitreous detachment (PVD) was performed and posterior hyaloid was removed. The PVD was advanced until equator, but not further. The vitreous in front of the equator was trimmed, however it was not removed totally. Then ILM was stained with 0.025% Brilliant Blue G 250 over the macular region. After waiting 20 seconds exposure time, the dye was aspirated with back-flush needle. The ILM was peeled around the macular hole across the macula for the whole area within the arcade using an end-gripping ILM forceps. If we observe a peripheral retinal degeneration during the surgery, we applied a prophylactic laser photocoagulation around the degeneration. Then fluid air exchange was performed. One of the trocars was removed and the closure of sclerotomy was checked. Sulfur hexafluoride (SF6) or perfluoropropane (C3F8) gas line was attached to the infusion line, and a back-flush was placed to the other trocar. After the gas was injected to the vitreous cavity, rest of the trocars was removed.
If cataract was observed in the preoperative evaluation, a combined phacoemulsification and intraocular lens (IOL) implantation was also planned. Combined cataract surgery was performed with the phacoemulsification before vitrectomy procedure. After inserting and anterior chamber maintainer a side-port was created from 10 o'clock for the right eye and 2 o'clock for the left eye. The continuous curvilinear capsulorrhexis was created with a cystotome. Then a 2.5 mm limbal corneal tunnel was created from the steep region of the cornea keratometric measurement of the patient. Phacoemulsification (EasyPhaco, OS4, Oertli Instrumente AG, Berneck, Switzerland) was followed by aspiration of cortical remnants. The intraocular lens used in all eyes was a 3-piece hydrophobic acrylic IOL (Sensar, Acrylic IOL AR40e; Abbott Medical Optics, Inc. Santa Ana, CA, USA). At the end of the cataract surgery anterior chamber was left with viscoelastic solution. Then we proceeded to pars plana vitrectomy in order to keep the anterior chamber stabilized during the surgery. The viscoelastic solution was removed at the end of vitrectomy before fluid air exchange.
The patients were positioned face down for 3 days. The follow up visits were scheduled as 1st day, 1st week, 1st month, 3rd month, 6th month and 1st year. If the macular hole persisted after surgery, a revision surgery was performed. In revision surgery we did not remove the residual vitreous. After placing 23 gauge trocars, 0.025% Brilliant Blue G 250 was poured over macula to visualize remaining ILM. Then liquid perfluorocarbon (PFCL) was injected to cover whole macular area in order to manipulate the ILM flep, graft and close the hole. The recurrent holes were closed in three ways. In the first patient, the ILM was peeled in small area in the previous surgery, an ILM flep was created close to macular hole, and it was inverted over the hole. In the second patient, an ILM graft was harvested and tucked inside the well of the macular hole. In the third patient, we advanced the edges of the hole by massaging, and aspirated the subretinal fluid from the well of the hole with 41 G backflush under PFCL. This third maneuver usually helps us to close the hole during surgery. In revision surgery SF6 or C3F8 were used as tamponade in all of the cases.

Follow-up Examinations
In pre-operative examination and post-operative follow-up examinations best corrected visual acuity, intraocular pressure, biomicroscopy and fundus of the patients were evaluated. Additionally, optical coherence tomography (OCT, Heidelberg Engineering GmbH, Heidelberg, Germany) was also performed in all visits.

Statistical Analysis:
All statistical analyses were performed using IBM SPSS for Windows version 20.0 (SPSS, Chicago, IL, USA). We performed a Post-hoc analysis and the power of the study was calculated as 92% based on intraocular pressure with an alpha error of 0.05, and with an effect size of 0.48 using G*Power 3.1.9.2 (Kiel University, Kiel, Germany) software. Assumption of normality was assessed by one sample Kolmogorov-Smirnov test. Normally distributed continuous variables were expressed as mean ± standard deviation while the continuous variables that do not have normal distribution were expressed as median (25. percentile-75. percentile). Normally distributed continuous variables between groups (regarding gas groups) were compared using Student's t test. For non-normally distributed continuous variables, differences (between before and after surgery results) were tested using Wilcoxon Signed Ranked Test. A two-sided p-value<0.05 was considered as statistically significant.

RESULTS
Fifty-two patients with macular hole were evaluated. Twenty-seven (51.91%) of the patients were male, and 25 (48.07%) of them were female. The mean age of the patients was 62.02±12.05. (Table 1)
The median visual acuity was 0.2(0.1-0.4) before surgery, and it was 0.5 (0.3-0.6) 12 months after surgery. Post-operative visual acuity was significantly higher than the pre-operative visual acuity (p<0.001). The mean intraocular pressure was 15.71±3.77 mmHg before surgery and it was 14.12±2.56 mmHg 12 months after

surgery. Post-operative intraocular pressure was also significantly lower than pre-operative intraocular pressure (p=0.023).
Twenty-two (42.3%) patients had combined phacoemulsification and IOL implantation. There was no difference in final visual acuity between the patients who had only vitrectomy, and the ones who had combined procedure (p=0.610). We did not observe any major complication related with the additional operation. Only two patients had posterior synechiae of iris, which did not affect visual acuity (3.84%). The eyes were filled with gas at the end of the surgery. SF6 (14% gas) was used in 24 patients (46.2%), and C3F8 (14% gas) was used in 28 patients (53.8%). None of the patients had retinal break during the surgery. We did not observe retinal tear, retinal detachment or proliferative vitreoretinopathy in any patients during follow-up. Three patients (5.76%) had revision surgery because of the recurrence of macular hole. These holes were closed successfully after reoperation.

DISCUSSION

Iatrogenic retinal break is one of the most serious complications in macular hole surgery. Retinal breaks may occur because of the existing peripheral retinal degeneration or traction of the retina by vitreous during surgery. This traction may be created by vitreous incarceration into the sclerotomy site or accidental vitreous traction during instrumentation. Rizzo et al. reported similar post-vitrectomy retinal detachment incidence in small gauge vitrectomy compared with 20-gauge surgery (2). On the other hand some studies report that incidence of retinal breaks was higher with the 20 gauge vitrectomy, compared to 23-gauge vitrectomy (3,4). These studies suggest that incidence of these two traction reasons may be reduced by the 23-gauge or 25-gauge trocar systems use (5). Today most of the surgeons are using trocar systems in macula surgeries.
Another reason for vitreous traction during surgery is separation of the vitreous from retina and advancing it up to the vitreous base. If there is a focal area of vitreoretinal adhesion, applying stress to this adhesion may increase the risk. Rahman et al. reported that rate of iatrogenic retinal breaks associated with posterior hyaloid face separation during 23-gauge PPV was 18.2%. They concluded that mechanical detachment of posterior hyaloid increases the risk of rhegmatogenous retinal detachment and is an important risk factor in formation of retinal breaks (6). Chung et al. reported that retinal breaks related to the macular hole surgery were 14.6%, and they have detected post-operative retinal detachment in 2.2 % of their patients (7). They commented that while pushing forward the PVD to the peripheral retina, traction would be forced on the posterior vitreous base margin, which may cause retinal breaks in any predilection to retinal meridian. We believe that leaving the peripheral vitreous would decrease the risk of retinal breaks in macular hole surgery. In the current study, we did not perform complete removal of the peripheral vitreous and none of our patients had retinal breaks during surgery or retinal detachment during follow up.
Limited vitrectomy has been proposed in a few recent studies. Kim et al. suggested that partial posterior hyaloidectomy could decrease the incidence of the traction on the vitreous base and minimize the risk of iatrogenic breaks in patients with macular hole and epiretinal membrane (8). Their technique is to remove as much of the vitreous gel as possible before PVD. The PVD was induced by engaging the posterior vitreous with a 23G needle with angulated tip. But the PVD was limited approximately two-disc diameters distance beyond the margin of the temporal major vascular arcade. In our study we conducted PVD after core vitrectomy and then we trimmed the anterior vitreous without extending the vitreous base. Although the sequence of PVD is different, both studies aim to reduce the traction in the vitreous base. Similar to our results, they reported that the rate of retinal break formation was significantly lower compared with conventional 23G surgery. They found retinal breaks related to surgery only in two eyes (3.4%) during postoperative examination. Both of their patients were in macular hole surgery group. Cullinane et al. performed posterior hyaloid peeling only in the macular area (9). Retinal tears were not observed in this group during the surgery, and two (3.6%) patients had postoperative retinal detachment. They found a similar post-operative retinal detachment rate (4%) in the conventional vitrectomy group. Additionally, they observed intraoperative retinal tears 5 (6%) patients in the conventional vitrectomy group.
PVD has shown to be correlated with the incidence of retinal breaks. (7,10) It has been reported that postoperative retinal break rate was significantly higher in macular hole patients than in epiretinal membrane patients (7,11). Chung et. al explained that vitreous architecture was different in macular hole and epiretinal membrane patients. The prevalence of PVD in idiopathic ERM patients has been reported to be 57% to 90% and the prevalence of PVD in macular hole patients has been reported to be approximately 20% to 40%. (11-13) PVD was observed in 78.5% of the patients with ERM and in 23.4% of the patients with MH in their study (7). The authors suggested that surgeons must be cautious because of the accompanying retinal breaks that occur with PVD induction. Tan et. al also reported that retinal breaks were found more often in eyes which PVD was induced during surgery (20.8%) compared with the incidence in eyes in which PVD was present already at the begining of the surgery (10.0%) (14). It may be hypothesized that attached posterior vitreous might be continuous with the attached peripheral vitreous, and trying to advance the detachment might cause an unnecessary traction to the peripheral retina. This might lead to an additional risk of retinal breaks.

Kamizuru et al. showed that the lattice degeneration (LD) was seen more often in eyes with macular hole compared to controls (15). In another study the incidence of lattice degeneration was found 33.88% in macular hole patients (16). Yagi et al. evaluated the relation of iatrogenic retinal breaks and the LD frequency in patients with MH and ERM. They revealed LD in 17.7% (14/79 eyes) in MH group and 9.8% (4/41 eyes) in ERM group. The rate of retinal breaks was 71.4% in those with LD in the MH group. They concluded that rate of LD and retinal breaks were significantly higher in eyes with MH (10). Since LD is a risk factor for iatrogenic retinal breaks, avoiding traction to LD area might be a precaution for retinal breaks. In our study, we did not remove the vitreous over these peripheral retinal degenerations and we applied prophylactic laser photocoagulation around that area. We did not observe retinal break or postoperative retinal detachment in any of our patients.

We used intraocular gas tamponade in order to maintain immobilization and apposition of the hole edges in all patients. One might think that residual vitreous might induce contraction and cause postoperative retinal breaks or retinal detachment. However, we did not observe of these complications as we mentioned before. Another problem leaving the peripheral vitreous might be inadequate filling of the gas tamponade. But the amount of the gas was enough to close the hole in most of our patients. Only three patients had recurrent macular hole after surgery. The macular holes of these patients were closed successfully after revision surgery.

Recently it has been advocated that using long lasting tamponades with pars plana vitrectomy may achieve closure of the macular hole without face down positioning (17-20). They claim that the patients underwent macular hole surgery are usually old and have comorbidities that reduce the compliance with posturing. It has been also reported that the success of this technique was reduced in macular holes larger than 400µ. We recommended a face down position to all our patients. The effect of face down positioning and no face down positioning may also be compared in patients with limited vitrectomy.

In our study we did not compare our patients' results with a control group composed of patients with complete vitrectomy. We only presented our technique and compared the results with the literature. This may be the weakness of our study. Comparing our technique with a conventional control group might strengthen our results.

In conclusion, limited vitrectomy without removing peripheral vitreous is safe and effective in macular hole surgery. It reduces the risk of peripheral retinal breaks and retinal detachment. We believe that limited vitrectomy could be accepted as the standard procedure of the macular hole surgery.

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Table 1. Clinical and surgical characteristics of the patients	
	Results
Mean Age±SD	62.02±12.05
Gender Male Female	 27(51.91%) 25(48.07%)
Median visual acuity (25. percentile - 75. percentile)[a] Pre-op Post-op (12 months)	 0.2(0.1-0.4) 0.5 (0.3-0.6)
Mean IOP±SD[b] Pre-op Post-op (12 months)	 15.71±3.77 14.12±2.56
Post-op recurrence of hole	3(5.76%)
Combined cataract surgery[c]	22(43.3%)
Tamponade[d] SF6 C3F8	 24(46.2%) 28(53.8%)
There was statistically significant difference in visual acuity and intraocular pressure between pre-op examination and post-op examinations. There was no difference in final visual acuity between intraocular tamponades. There was no difference in final visual acuity between the patients with combined cataract surgery and the ones without. ([a] p=0.000, [b] p=0.023 [c] p=0.610, [d] p=0.866)	